

WRIGHT

Effect of Certain Fertilizers
And Moisture on the Quality
And Quantity of String Beans

Agriculture

B. S.

1905

UNIVERSITY OF ILLINOIS
LIBRARY

Class

1905

Book

W93

Volume

Je 05-10M



$\frac{409}{169}$ 409 D.

EFFECT OF CERTAIN FERTILIZERS AND
MOISTURE ON THE QUALITY AND QUANTITY
OF STRING BEANS

BY

HERMAN FESTUES WRIGHT

Thesis for the Degree of Bachelor of Science
in Horticulture

COLLEGE OF AGRICULTURE
UNIVERSITY OF ILLINOIS

1905

UNIVERSITY OF ILLINOIS

May 29

1905

THIS IS TO CERTIFY THAT THE THESIS PREPARED UNDER MY SUPERVISION BY

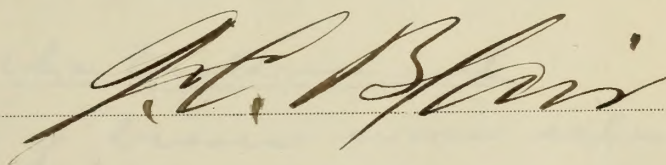
HERMAN FESTUES WRIGHT

ENTITLED "EFFECT OF CERTAIN FERTILIZERS AND MOISTURE

ON THE QUALITY AND QUANTITY OF STRING BEANS"

IS APPROVED BY ME AS FULFILLING THIS PART OF THE REQUIREMENTS FOR THE DEGREE

OF BACHELOR OF SCIENCE IN AGRICULTURE



HEAD OF DEPARTMENT OF Horticulture

75387

Digitized by the Internet Archive
in 2013

Introduction.

Although string beans constitute a crop of considerable importance, it seems that little attention has been given to studying their cultural requirements; and it was deemed advisable to undertake some investigation with a view of determining, if possible, what factors of environment, if any, affect their yield and quality.

The main object of the experiment reported in the following thesis was to find out, if possible, whether or not the yields and quality of string beans could be materially affected by moisture, and also by the liberal use of certain plant fertilizers.

Plan of the Experiment.

Two varieties of beans were selected for the experiment. One variety was known to be very stringy, or in other words, of very poor quality, and the other was claimed to be stringless.

The former was the "Early Mahoeak", the seed of which was obtained from Vaughan's

Introduction

Although many people are familiar with the name of the University of the Pacific, few are aware of its rich history and the many contributions it has made to the world. The University of the Pacific was founded in 1862 and has since then been a leading institution of higher learning. It has produced many notable graduates who have gone on to make significant contributions in various fields. The University of the Pacific is a member of the Association of American Universities and is recognized as one of the top universities in the world. It is a place where students can receive a world-class education and where faculty members can pursue their research interests. The University of the Pacific is a place where the past meets the future, and where the best of both worlds can be found.

History of the University

The University of the Pacific was founded in 1862 by a group of men who were dedicated to the cause of higher education. They believed that education was the key to a better future, and they wanted to provide a place where students could receive a world-class education. The University of the Pacific was the first university in the United States to be founded by a group of men who were dedicated to the cause of higher education. It has since then been a leading institution of higher learning, and it has produced many notable graduates who have gone on to make significant contributions in various fields. The University of the Pacific is a place where students can receive a world-class education and where faculty members can pursue their research interests. The University of the Pacific is a place where the past meets the future, and where the best of both worlds can be found.



Seed Store, of Chicago, and the latter was the "Stringless Greenpod," from H. Atlee. Burpee and Company, of Philadelphia, Pa.

Since the experiment was conducted during the winter it was necessary to grow the plants under glass; and the south bench of the south-west house of the horticultural range was selected as the place best suited for the work. The bench was 28 feet, 4 inches long and 36 inches wide, and was furnished with bottom heat by means of ^{ten} steam pipes, any number of which could be cut off at will so that the temperature was at all times under perfect control. The bottom of the ^{bench} was made of regular green house tile so laid as to leave openings for the surplus water to escape. The bench was divided into ten plots, each 34 inches long and 36 inches wide, by means of 6 inch boards extending across and to the bottom of the bench, thus preventing the mixing of the soil of the different plots. These plots were numbered from left to right as I, II, III, IV,

V, VI, VII, VIII, ~~IX~~, and X.

Soil was placed on the bench, or rather in the plots, to a depth of six inches, and plant food was applied to the soil in all the plots except that in plots I, II, III, and X.

Plots I, II, and III, were used in the moisture experiment and the soil in these three plots was taken from plot V. of the horticultural grounds of the Experiment station, and so far as is known, has never received an application of manure or commercial fertilizer of any sort. These plots received no application of plant food, and as before stated, were used in the moisture experiment, and plot III was used also as a check plot, to compare with those plots to which plantfoods were applied.

The treatment given the first three plots during the experiment was as follows: Plot I received practically no water after the plants began to bloom. During the rest of the season water was applied only once and then only about one gallon of water was used.

Up to the time of blooming plot I had received the same amount of water as applied to the other plots, thus giving all the plants the same chance to grow.

The soil in plot II was kept thoroughly wet after the first blooms appeared until the end of the season; while plot III received only enough water to insure a good healthy growth of the plants.

Plots IV, V, VI, VII, VIII, and IX, made up the fertilizer experiment, and plant food was applied to all as follows:

To plot IV, one part well rotted barnyard manure to two parts soil. Plot V, contained the manure also, but in addition received applications of Nitrate of Soda at the rate of 800^{lb} per plot or about 2400^{lb} per acre, ^{divided into three applications made} at intervals during the growth of the plants. In addition to the manure,

4 ounces of bone meal, ^{or} at the rate of about 1200^{lb} per acre, were thoroughly mixed through the soil in plot VI.

This amount of bone meal is about twice the amount usually applied to soil under field conditions, but was used in order to give the plants a chance to secure all the food that they could use.

The same amount of Nitrate of Soda, as was used on plot IV, and bone meal, as was used in plot VII, and also manure in the proportions used in plot IV, were applied to the soil in plot VIII. And the same fertilizers in the same quantities were applied to plot VIII, with an addition of 4 oz. of potassium sulphate, ^{or} at the rate of 1200^{lb} per acre. Plot IX, contained no manure, bone meal or potassium sulphate, but was treated with nitrate of soda. The same soil was used in this latter plot as was used in plots I, II and III. The soil in plots IV, V, VI, VII and VIII, was of the same character, but from a different plot.

The soil in plot IX, was white clay which originally came from southern Illinois and had been used in a previous experiment without the addition of fertilizers. In this experiment no plant food was added, and the plot was used as a check plot representing a very poor soil.

Planting of the Seed.

The seeds were planted, ^{in the different plots.} after thoroughly pulverizing and mixing the soil, on the afternoon of November

22. 1904. The two varieties, the "Early Mohawk" and the "Stringless Greenpod", were planted in all the plots which were ^{previously} divided into two sections, each of which contained 15 hills, six inches apart each way. In one section the "Early Mohawk" seeds were planted and in the other ~~were~~ planted the "Stringless Greenpod" seeds, making a total of 30 hills to each plot. The seeds were planted about one inch deep, with two seeds to the hill. Except in a very few cases all the "Early Mohawk" seed germinated, but on account of old and poor seed the "Stringless Greenpod" failed to germinate.

In all missing hills of the "Early Mohawk," plants were transplanted from those hills where both seeds germinated. All hills were thinned down to one plant each, so that each section containing the "Early Mohawk" contained just 15 plants.

On account of the failure of the "Stringless Greenpod" seed to germinate, and having no more seed at hand, the second sections of each plot was planted with the "Early Mohawk" seed on Tuesday

afternoon, December 13, 1904, just 21 days after the first planting. These in turn received the same treatment as to thinning and transplanting as did those of the first planting. Some of the seed however did not germinate, so a full stand of 15 plants per section was not obtained; therefore, each section contained the following number of hills, with one plant per hill. I - 5 hills, II - 11 hills, III - 12 hills, IV - 14 hills, V - 7 hills, VI - 11 hills, VII - 14 hills, VIII - 13 hills, IX, and X, - 15 hills each.

Germination.

No exact data as to the time of the germination of the seeds of the different flats, in the first experiment, were kept, but it was particularly noticeable that the first seeds to germinate were those in flats IX and X, and the last, in plot VI. The difference in time of the germination must have been due principally to the texture of the soil as the organic matter present could not affect the temperature, as it was under control. The soil without the manure packed closer

around the seeds, thereby causing them to germinate more quickly by warming from the closely packed surrounding soil.

It is a fact however and has been proved by experiment that where temperature and other conditions are uncontrolled that the presence of organic matter in a soil will hasten germination of seeds, by absorbing heat from the sunlight.

Care of the Crop.

The temperature under which the plants grew was at all times ideal. ~~They experienced~~ no sudden changes, as is often the case when plants are grown in the open air. A regular temperature, of 70°F. at night and ^{about} 75°F. during the day, was kept during the entire growing season of the plants.

The cultivation consisted of removing all weeds and occasionally pulverizing the soil which often formed a crust on the surface after watering.

Watering.

The watering of the plants, the most important item in their care received strict attention. The plants

were watered every two days, each plot receiving about two gallons of water per watering, except in the case of the first ~~three~~ plots. These two plots were in the moisture experiment and received the following amounts of water:— Plot I was given ~~practically~~ no water after blooming began, except in one case when about one gallon of water was used when the plants were wilting badly.

Twice as much water was given to plot II as to plot III, that is, about four gallons every other day, plot III receiving the same amount of water as the remaining plots, ^{that is} about two gallons every two days.

Application of Nitrate of Soda.

The first application of nitrate of soda was made to plots V, VII, VIII, and IX, on December 24, 1904, at the time the plants of the first planting, that of November 22, 1904, were in full bloom. The plants of the planting of December 13, 1904 which were small, received the application of nitrate of soda at the same time because there was no way of preventing

it. The nitrate of soda was dissolved in water and applied to the soil by means of a sprinkler in such ^a way as not to allow any of the solution ^{to} fall upon the foliage of the plants; because the concentration of the solution would turn the leaves yellow and cause them to die. For the first application, 3 oz. of the salt were dissolved in about two gallons of water and applied as above. stated, ^{to each plat.} In the second application, which occurred one week later than the first, 3 oz. of the salt were again used in the same manner as the first. In the third application which was made two weeks after the first, only 2 oz. of the salt were used. Thus, in all three applications of the nitrate of soda, 8 oz. of the salt were used to each plat receiving the treatment.

Yields from the Various Plots. First Planting.

The first beans to be picked came from those plants, the seeds for which were planted on November 22, 1904. The first picking was made on January 10, 1905. Just 49 days after the first seeds were planted. It will be remembered

^{that} in the first planting, each section contained exactly 15 plants. The following tables show the total number of pods gathered from each plat^(table I.), and their total weight in grams^(table II.), also the date of each picking.

<u>No. of Pods.</u> <u>Table I.</u> <u>First planting.</u>											
<u>Date.</u>	<u>I</u>	<u>II</u>	<u>III</u>	<u>IV</u>	<u>V</u>	<u>VI</u>	<u>VII</u>	<u>VIII</u>	<u>IX</u>	<u>X</u>	
Jan. 10. 1905	1.	6.	3.	4.	5.	4.	1.	5.	9.	21.	
" 16 "	6.	24.	24.	28.	24.	23.	16.	16.	11.	5.	
" 24 "	6.	8.	7.	22.	13.	23.	16.	12.	4.	3.	
" 31 "	2.	0.	0.	5.	0.	13.	10.	5.	0.	0.	
Feb 9. "	0	3.	0.	1.	2.	0.	0.	1.	8.	11.	
" 18 "	0.	13.	4.	6.	11.	1.	2.	4.	12.	14.	
" 25 "	3.	14.	10.	13.	17.	7.	12.	18.	13.	5.	
Mch 4 "	<u>0</u>	<u>6</u>	<u>13</u>	<u>10</u>	<u>27</u>	<u>23</u>	<u>14</u>	<u>12</u>	<u>6</u>	<u>5</u>	
Totals	18	74.	61	89.	99.	94.	78	73.	63.	64	

A perusal of the above table will show that the greatest number of pods come from plats V, and VI. The former was treated with nitrate of soda and Manure, and the latter, bone meal and manure. The smallest number of pods came from plats I, III, ~~IX~~, and X. Plats I and III were in the moisture test and received no application of plant food, nor

was plant food added to plat V, which contained the very poor soil. But plat ~~V~~ received the nitrate of soda treatment.

The difference between the number of pods harvested from plats V and ~~V~~, ^{and plant food} must be due the organic matter, in the form of manure, present in plat V. The effect of nitrate of soda ^{alone} is shown ^{to be very slight} when the yields of plats ~~III~~ and ~~V~~ are compared.

Bone meal gave almost as good results in the number of pods, when in combination with manure, as did nitrate of soda, used in connection with manure.

It will be noticed that plat VII and VIII, both containing more plant foods than any of the other plats, produced only average yields.

The size of the pods which were harvested from the different plats can best be compared, by their weights, which ^{are shown in} the following table

From first planting.

Table II Wts. = grams.

Date of picking.	I	II	III	IV	V	VI	VII	VIII	IX	X
June, 10. 08.	3.5	29.3	16.2	22.6	29.1	20.5	4.9	23.4	34.8	84.8
" 16 "	20.	113.5	103.5	153.	113.5	114.5	70.	59.	31.2	21.8
" 24 "	11.6	24.8	18.2	97.1	51.	111.3	71.6	44.9	8.6	18.
" 31 "	4.8	.0	.0	17.2	.0	70.4	54.5	27.5	.0	.0
Feb. 9 "	.0	12.2	.0	5.9	17.9	.0	.0	2.6	30.0	57.2

continued.

Table III. concluded,

Weights of pods in grams.

Date of picking	I.	II.	III.	IV.	V.	VI.	VII.	VIII.	IX.	X.
Feb 18. 1905.	0.	63.	95.	25.	64.5	45.	13.	20.	52.	58.
" 25 "	8.5	63.	52.	76.	96.	36.5	43.5	80.5	38.5	17.5
Mar 4 "	.0	17.5	61.	42.	93.	82.5	59.	64.5	19.	12.5
Totals.	48.4	323.3	260.4	388.8	466.	438.2	316.5	323.4	215.1	267.8

The above tables show that the greatest weight of the pods came from plots V. and VII. as did the greatest number of pods, also that the smallest yield in weight came from plot I. The size of the pods produced by the different plots is better found by getting an average of the weight of each pod from each plot. This is brought out, or rather better illustrated in table V which follows later. (See page 15).

Yields of Second Planting.

The first picking from the planting of December 13, 1904 was made January 31, 1905. fifty days after the seeds were planted. The two following tables show exactly the same things in reference to the second planting as are given in tables I. and II for the first planting.

Number of Pods.	Table III.										Second Planting
Date of Picking	I	II	III	IV	V	VI	VII	VIII	IX	X	
Jan 31, '05	0;	19.	7.	5.	6.	3.	6.	18.	10.	11.	
Feb. 9 "	1.	18.	10.	22.	23.	20.	30.	25.	20.	8.	
" 18 "	1.	6.	8.	10.	6.	16.	15.	7.	1.	0.	
" 25 "	2.	0	0.	1.	1.	12.	3.	0.	0.	0.	
Mch 4 "	~~0.~~	~~2~~	~~2~~	~~5~~	~~2~~	~~2~~	~~3~~	~~4~~	~~4~~	~~9~~	
Totals	4.	42.	27	43	38	53	57	54	35	28	

Plants per plot 5. 11 12 14 7. 11 14 13 15 15

The weights of the above pods were as follows. weights in grams.

Date of picking	Table IV.									
	I	II	III	IV	V	VI	VII	VIII	IX	X
Jan 31, '05	.0	5.5	4.5	15.	6.5	7.	7.	11.5	22.5	39.5
Feb 9, '05	2.5	.0	.0	4.5	7.	57.5	9.5	.0	.0	.0
" 18, "	2.	13.	21.	27.8	33.	72.2	37.	19.5	3.	.0
" 25, "	2.	52.7	30.7	114.	122.	104.5	135.5	102.7	71.6	19.
Mch. 4. "	~~0.~~	~~81.~~	~~27.~~	~~21.~~	~~28.5~~	~~14.2~~	~~23.5~~	~~71.2~~	~~38.2~~	~~38.7~~
Totals	6.5	153.2	83.2	182.3	197.	256.7	226.5	204.9	135.3	97.2

The above table as they stand do not in all cases show ^{the} same results as those given in tables I and II; but it must be remembered that the ^{different} plots or sections did not contain the same number of hills. ~~At the same time~~

the sections have contained 15 hills each, like those sections of the first planting, instead of an unequal number, the results undoubtedly would have shown the same.

The two following tables, V and VI, show the results obtained, more plainly than the two preceding tables, because the average number of pods produced by each plant, and the average weight in grams per pod, from the different plots are shown; and also the total number of pods and the total weight of the same in grams are given, with the treatment of the different plots.

Table V First planting.

Plot.	Treatment.	Total pods.	Total wt.	Avg. Pods per Hill	Avg. wt. ^{each} of Pod.
I.	Drought	18.	48.4	1.23	2.6
II.	Heavy water	74.	323.3	4.4	4.37
III.	Ordinary water.	61.	260.4	4.06	4.29
IV.	Manure.	89.	388.8	6.	4.32.
V.	Man. + NaNO_3	99.	465.	6.6	4.70
VI.	.. + Bone M.	94.	438.2	6.26	4.68
VII.	Man. B.M. + NaNO_3	78.	316.5	5.2	4.45
VIII.	^{K_2SO_4} Man. B.M. + NaNO_3	73.	322.4	4.9	4.35
IX.	NaNO_3	63.	215.1	4.24	3.41
X.	White Clay.	64.	263.8	4.26	3.9

The following table contains the data calculated from the second planting of Early Mohawk seed, and, in connection with the yields, weights, and averages, gives the number of plants in each plot.

Table VI, Second planting.

Plot	Treatment.	No. Hills or plants.	Total pods.	Total wt.	av. pods per hill or plant.	av. wt. per pod.
I.	Brought,	5.	4.	6.5	.8	1.62
II.	Heavy water,	11.	42.	153.2	3.81	3.64
III.	Ordinary water.	12.	29.	83.2	2.2	3.08
IV.	Manure.	14.	43.	182.3	3.07	4.24
V.	Man. + NaNO_3	7.	38.	197.	5.4	5.78
VI.	" + Bone meal,	11.	53.	256.9	4.81	4.84
VII.	" B.M. + NaNO_3	14.	57.	226.5	4.07	3.97
VIII.	Man. K_2SO_4 B.M. + NaNO_3	13.	54.	204.9	4.15	3.79
IX.	NaNO_3	15.	35.	135.3	2.3	3.86
X.	White clay.	15.	28.	97.2	1.86	3.47

In the last two tables, V and VI, the results are shown quite plainly, especially in the averages. Plots I and II, show both the greatest average number of pods per plant, and the greatest average weight per pod. The smallest averages, like the total yield

in the number of pods and weight come from I and II. The smallest averages in the fertilizer experiment come from ^{plate} III, and II, the two check plots, while in the moisture experiment plot II, which had received heavy applications of water produced the greatest number of pods, the highest average number of pods per plant and pods of the greatest average weight. The average weight ^{per pod} was .62 grams greater in the pods from plot II than in those pods from plot III.

According to the data and averages computed, soil containing manure, ^{and} bone meal, or manure and nitrate of soda, with plenty of water, will produce the greatest number of pods per plant, and also the largest pods dry weight, at a certain age. As all the pods were picked as near the same age as possible, the age counts nothing in the difference in the weights of the pods from the different plots: the difference therefore being due to the environmental differences. The differences between the yields of the plants on plots ^I II and III, show that the amount of moisture

present in the soil does materially affect the yields of green beans.

To further illustrate the differences of environmental effects, the ^{number of} developed beans in each pod was counted.

The following tables show, very well, the size of the pods from the different plots, by giving the percentages of the pods containing the different numbers of developed beans per pod.

First planting. Table VII. Beans per pod.

Plot.	Total pods	1.	2.	3.	4.	5.	6.
I.	18.	38.8	38.8	16.7	5.5	.0	.0
II.	74.	13.6	17.5	37.8	24.3	5.4	1.35
III.	61.	13.25	19.6	39.3	22.9	1.63	1.63
IV.	89.	10.1	23.3	27.	29.1	5.62	4.5
V.	99.	9.	16.1	38.2	26.1	10.1	.0
VI.	94.	4.25	19.2	37.1	29.4	14.5	26.5
VII.	78.	8.9	23.4	32.4	30.4	.0	
VIII.	73.	17.8	26.	39.4	13.7	2.72	
IX.	63.	31.7	33.4	25.8	9.5	.0	
X.	64.	12.5	37.6	31.3	18.75	.0	

The following table gives the percentages of the developed beans in the pods from the different plots, of the second planting of the "Early Mohawks".

Table VIII.

Percentage of branched pod.

Plot.	Total pod.	1.	2.	3.	4.	5.	6.
I	4.	75.		25.			
II	42.	28.6	16.6	30.8	23.8		
III	28.	39.3	17.8	25.	17.8		
IV	43.	18.6	16.6	27.8	27.8	9.3	
V	38.	10.5	21.	29.	31.6	7.7	
VI	53.	13.2	15.1	35.8	26.4	7.5	1.8
VII	57.	29.8	17.5	22.8	21.05	7.	1.7
VIII	54.	29.6	22.3	22.3	20.4	3.7	
IX	35.	25.2	22.4	19.8	25.2	2.8	
X	28.	32.05	17.8	28.6	17.8	3.8	

Tables, VII and VIII, do not show as plainly as might be expected, ^{the} effects of the different fertilizers upon the number of developed branches in the pods. Plots III, and IX, the two checks, however, give the greatest percentage of pods containing only one branch, and plots V, and VI, produced the smallest percentage of pods containing one branch. The percentages of ^{the} pods from plots III and IX, decreased, with an increase of the number of developed branches per pod, until ^{about} 4 branches per pod were reached; while the percentages of pods from

plots V and VI, increased with an increase of the number of developed beans per pod, until about four beans per pods were reached. Six beans per pod was the maximum number found during the season.

Four beans per pod was about the average number for the whole lot.

Relative Vigor of the Plants.

On January 17, 1905, the following notes were made on the vigor of the plants of the different plots. The general appearance of the plants, as to the extent of their growth, and prospects for a continuance of bearing fruit, was taken into consideration. The variation in the size and color of the plants on the different plots was decidedly marked. The plants growing on plot I were very small and sickly looking, and the foliage possessed a yellowish color. There were no blooms or young pods present, and the prospects for any more in the future were very poor. The plants on plot II, which were

heavily watered, were robust and growing, possessing a very healthy color. They seemed to be in good bearing condition; however, but few blooms and young pods could be found. The failure to bloom must have been due to the rapid growth of the plants caused by the free use of water.

On plot III the plants were not so large and healthy looking as those on plot II, but the indications were good for more pods, as several blooms were present. The plants on this plot might be termed just "ordinary plants".

The appearance of the plants growing on plots IV, V, VI, and VII, differed but very little in ^{the} color of ^{the} foliage and ^{the} growth of ^{the} plants. The foliage was dense and the leaves were large, and all possessed a healthy color. They looked as if they were able to stand a much longer season of bearing than is commonly the case with green beans. The heaviest foliage was found on the plants of plot II, the leaves being about $\frac{1}{4}$ larger than those on any of the other plots.

Blooms and young pods were plentiful on all the above named plots.

The plants on plot VIII, which received all the different fertilizers used in the experiment, should, according to theory, have produced a larger growth of plants than any of the other plots; but instead, the plants were small, yet possessing a good green color. The plants compared very well with those on plot III as to size and color. The blooms and young pods were few as compared with those found on plots IV, V, VI, and VII.

Except the plant on plot I, the smallest plants of the whole experiment were found on plot IX. This plot received only the application of nitrate of soda and the plants should have possessed a larger growth, from amount of fertilizer added, than those plants on plot III. The plants however were short and stalky, with but few leaves. The crop seemed to be about ended as no blooms or young pods were present.

Long, dangling, plants, possessing but few leaves, were found on plot X.

The leaves had a yellowish appearance; while few blooms or young pods could be found. The lower leaves had begun to turn color and dry up.

On March 6, 1908, the entire crop of plants was removed from the flats in order to plant a second crop. The appearance of the plants on the different ^{at this date} flats, were as follows:- The plants on plat I were all dead. Several dead leaves were found on the plants in flats II, III, and IV, yet a few blooms and young pods were still present, showing that the plants were yet able to produce fruit.

Plats V, VI, VII, VIII, and IX were still growing and possessed a healthy color. Numerous blooms and young pods were present and but few dead leaves could be found.

The plants on plat X, like those on plat I, were exhausted, and had begun to dry up and die.

By comparing the growth of the plants on the different flats, it is easily noticeable that those on flats containing manure produced far better plants. The smallest growth of plants was found on plat I, the next smallest

on plot IX. The plants on the former plots were affected by the drought and those on plot IX, probably, from too concentrated a solution of nitrate of soda without the presence of organic matter.

The largest growth of plants was found on plots I and II, the two plots which produced such favorable results in the yields.

Quality of the Products.

Next to the yields in importance in the growing of a crop of green beans, is the quality of the pods, as it is the pods which make up the edible portion of the green beans. In this experiment the quality of the pods was determined by a microscopic examination of the structure of the pod, by breaking the pods to determine the extent of their stringiness, and by cooking, to determine their edible qualities.

A bean pod is composed of fundamental tissue bounded by an epidermis and traversed by vascular bundles, which in turn,

form the skeleton or frame work of the pod. The vascular bundles are divided into two parts; one which forms the backbone and the other answers the purpose of ribs.

The bundles which form the strings are found on both the dorsal and ventral sides of the pods, extending from one end to the other. Three forming the ribs extend diagonally around the pods and are connected with the strings on both the dorsal and ventral sides.

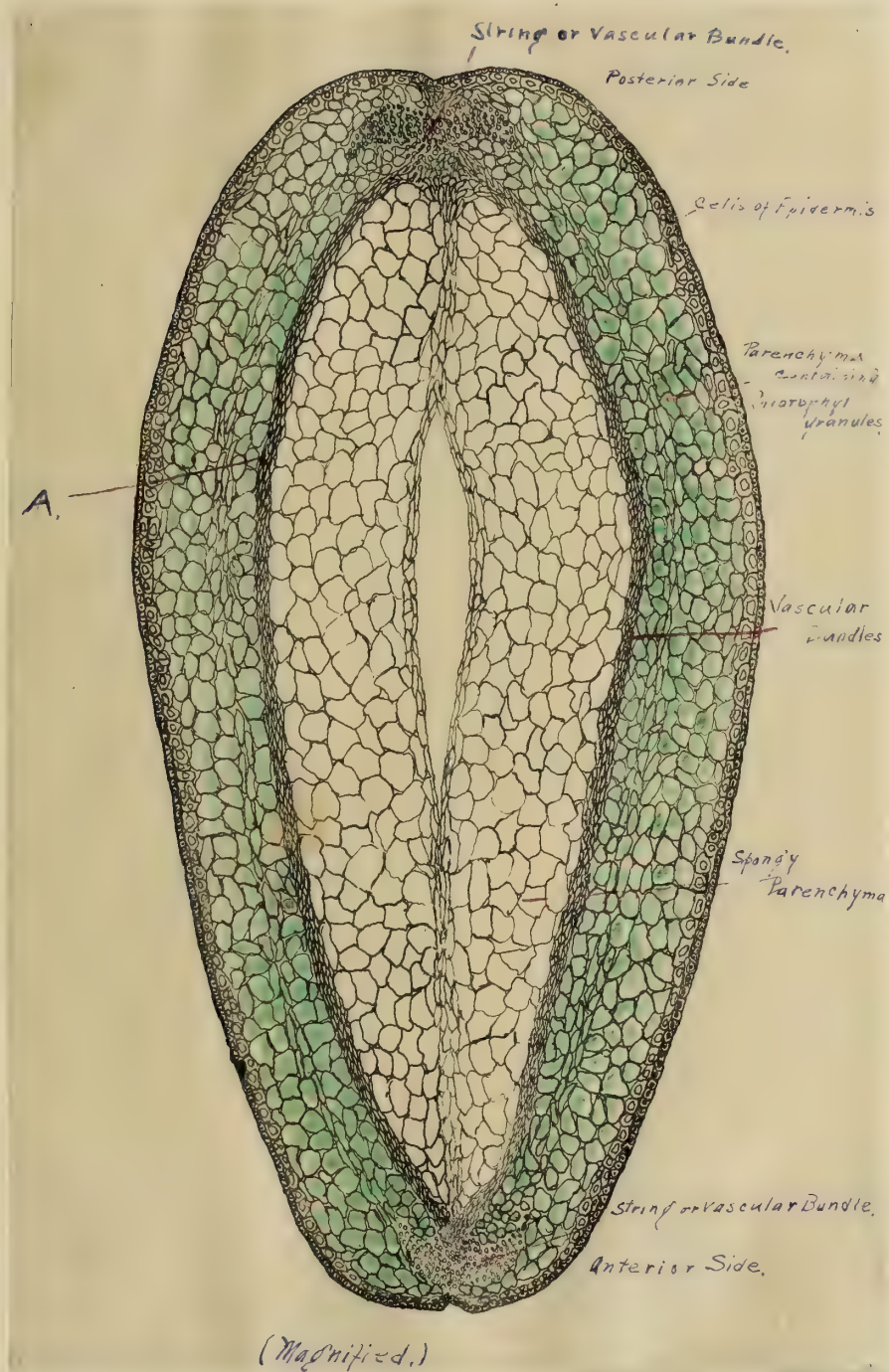
The vascular bundles are made up of tubular cells, the walls of which are composed of cellulose; and it is doubtless the extent of the development of these walls, that materially affects the quality of the pods for food purposes.

With the aid of the microscope no difference in the number of layers of the cells of the vascular bundles in the pods from the different plots, could be detected; nor was there any visible difference in the thickness of the cell walls.

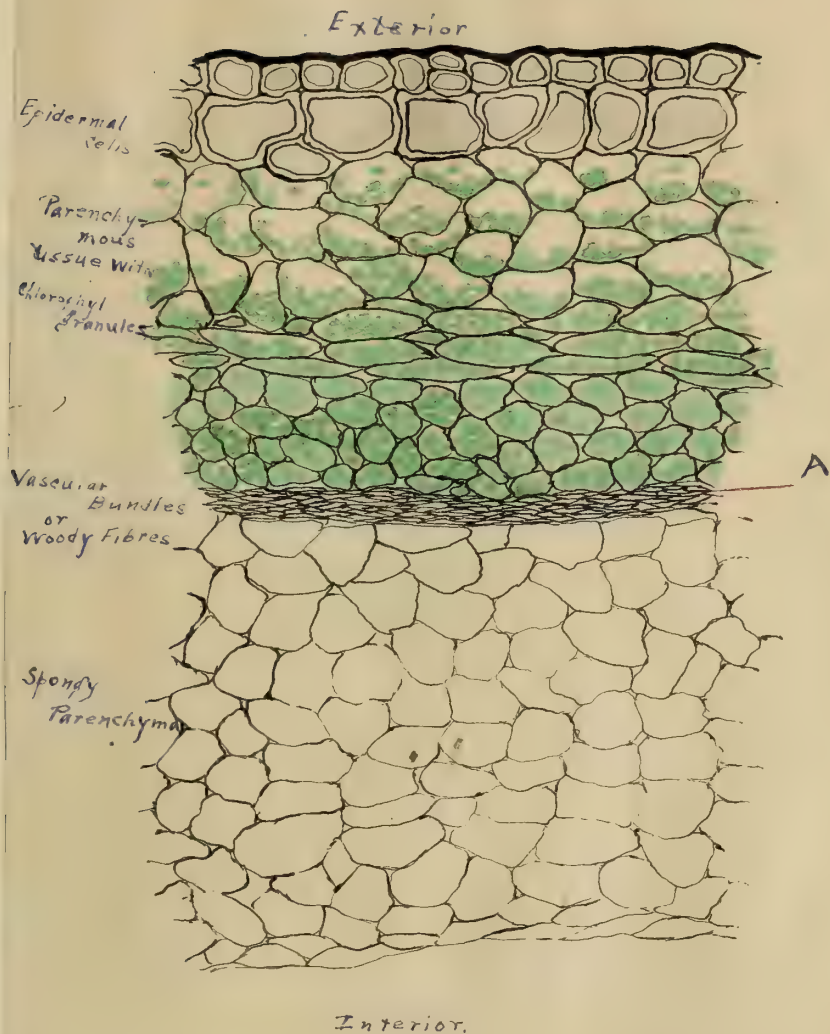
In all cases of examination there seemed to be a definite number of layers of cells of the vascular tissue which formed the ribs of the pods.

The layers in all cases were composed of three cells in thickness.

The following cuts with the explanations will show just where the pods are found in the pod, which are now or less responsible for the edibility of green beans.



Cut I- Entire cross-section of pod showing the location of the different tissues and the strings and woody tissues.



More highly magnified than in Cut no. 1.

Cut II- An enlarged portion of a cross section of a pod. In this cut there is a mistake at A in number of layers of cells drawn. There should have been only three layers instead of more, as is shown in this case.



Cut III. - This cut shows only a portion of a side view of vascular bundles which run diagonally around the pods. It is this part of the pod that ^{quickly} affects its eating quality, by forming the dry hard material which is left in

the mouth after mastication.

Breaking the Pods.

As no visible difference could be found, with the aid of the microscope in the thickness of the layers of vascular tissue, the next thing done was to break the pods in two. In breaking the pods the quality was determined by the amount of string that could be pulled off the pod. Very little difference in the amount of string present, was found in the pods from plates II, III, IV, V, VI, VII, VIII, and IX, but the pods from plate I, and X, seemed to possess strings that were tough and difficult to break. The pods, too, seemed to be dry and hard.

Cooking the Pods.

The third step in determining the quality of the pods from the different plates, was by cooking. The cooking tests were made in the laboratory with the aid of bunsen burners and 500 c.c. glass beakers. The pods were prepared for cooking by, first, pulling off as much of

the strings as possible, and breaking the pods in two. They were then placed in the brokers which had previously been marked and contained about 300 C.C. of water. Salt was added until the water was salty enough to suit the taste. The beans were then boiled for about one hour, at the end of which they were well cooked. During the process of cooking the water evaporated very rapidly and frequently had to be replaced with fresh water. When the beans were almost cooked a small piece of butter, about the size of a marble, was added to each broker for seasoning. Then after boiling for a few minutes longer they were allowed to cool; after which they were tested for quality by three competent judges beside myself. In determining the quality, the flavor of the pods, and the amount of woody tissues remaining in the mouth after thorough mastication, were taken into consideration.

The first cooking tests was made on Jan 17, 1905, with the pods picked

on the preceding day. The judges did not know from which plot the pods came nor anything regarding their treatment. After thoroughly testing the pods in all the breakers the following results were obtained by all four judges. Not one of the judges knew what had been the decision of the others until afterwards.

Plot VI was readily selected as the one producing pods ^{the most nearly} free from woody tissues and possessing the best quality. The pods from plots VII and VIII, were given second place.

Plot VII contained all plant foods used in the experiment, excepting potassium sulphate, and plot VIII ^{contained} all the plant foods. More woody fibre was present in the pods from the latter two plots, than ⁱⁿ those from plot VI, which contained only manure and bone meal.

The pods from plots IV, V, and IX, were placed third in quality on account of the flavor being much inferior to that of the pods from plot

VII and VIII.

Plots II^{and III} were given fourth place and plots I and X were readily placed last as the plots producing the poorest beans as to quality. The fibrous tissues was very evident in the latter pods, being very tough and hard to chew. The flavor was also poorest of all.

In selecting the pods for the cooking tests, pods were picked as near the same age and size as possible so that age did not affect the quality of the beans.

The second cooking test was made February 25, 1905. In this test exactly the same processes as were used in the first test were strictly carried out. The results obtained in this test only strengthened the exactness of those obtained in the first, because the same decisions were arrived at that were given for the first test.

On the same day, February 25, 1905, pods were picked at different ages and cooked in order to find out the best time for picking beans

for cooking. The pods were taken from plot II because they gave the best results in the preceding cooking tests. Pods were picked when the embryos branched had just begun to swell, when they were a little larger than turnip seed, and when they had reached the size of small cow-peas. After cooking and testing, it was readily decided that ^{the} youngest pods produced decidedly the best results. The oldest pods were dry and tough, without much flavor.

The second crop.

In order to secure check results for those obtained in the preceding crop, it was thought advisable to plant a second crop of beans; and as new seed of the "Stingless Greenpod" variety were then on hand, two-thirds of the crop was planted in them, and the other third in "Early Mohawk".

Before planting the seed for the second crop, fertilizers were added to those plots which had received applications of them for the first crop.

On March 9, 1905, five pounds of well rotted manure^{perfect} were added to plots IV, V, VI, VII, and VIII, 4 oz bone meal^{perfect} were also added to plots VI, VII, and VIII. In addition to the 5 pounds of manure and 4 oz of bone meal, plot VIII received 4 oz of potassium sulphate.

During the growth of the plants the applications of nitrate of soda, as planned for the preceding crop, were applied to plots V, VII, VIII, and IX. Plots I, II, III, and X, received no additional plant food, as they received none in the first place.

The plant foods were thoroughly worked through the soil, after which the seeds were planted as follows: 10 hills of each plot were planted with the "Early Mohawk" seed, and the remaining 20 hills were planted with the "Stringless Greenpod", fresh seed of the latter variety having been obtained from W. Atlee Burpee and Company.

Germination.

Exact data were kept as to the time of germination of the seeds in the different plots, in order to verify the

observations made upon the first crop. The following table shows the time of the germination of the seeds of the different plots.

Table IX.

Plots with number of Germinated seeds.

Date.	I	II	III	IV	V	VI	VII	VIII	IX	X
Feb. 14 '03									4.	5.
" 15 "	3.	5.	2.		5.	3.	16.	4.	12.	8.
" 16 "	16.	24.	20.	2.	20.	19.	16.	4.	21.	18.
" 17 "	19.	24.	22.	8.	21.	20.	17.	9.	22.	18.
" 20 "	27.	26.	23.	23.	21.	21.	21.	16.	25.	18.
" 21 "	27.	26.	23.	23.	21.	21.	21.	16.	25.	18.

As two seeds were planted in each hill only the number of hills were counted which contained plants through the soil.

On March 21, 12 days after the seeds were planted, every seed that germinated was through the soil. In most of the hills, there were two plants. One of these plants was used to transplant to the missing hills until every hill contained a plant. The superfluous plants were then pulled.

and destroyed.

As in the first crop the table shows that the first seeds to germinate were those planted in flats ~~IX~~ and ~~X~~, and the last ones to germinate were in flats ~~IX~~ and ~~VII~~ in this case. The differences ^{were} probably due to the texture of the soil.

The first plants to bloom were, like those first to germinate, found in flats ~~IX~~ and ~~X~~ and the last were found in flat ~~VII~~. This difference was due to the rank growth of the plants in that flat.

The watering and general care of the crop was, as near as possible, the same as that carried out for the first crop.

The first application of Nitrate of soda was made on March 28, 1908; the second, one week later, and the third two weeks after the first. The same amounts of the salt were used, as were used for the plants of the first crop: 30 g. each, for the first and second and 2 g. for the third and last application.

Only two pickings were made of the food from the second crop, owing to

the lateness of the season. The first was made April 24, 1905 and the second May 3, 1905. The following tables will give the ^{total} yields and averages for the two varieties. The weights are in grams.

Table X.

"Early Mohawk"

10 hills per plat.

<u>Plot.</u>	<u>Total pods.</u>	<u>Total wt. of pod.</u>	<u>Av. pods per hill.</u>	<u>Av. wt. of each pod.</u>
<u>I.</u>	26.	95.	2.6	3.6
<u>II.</u>	35.	163.	3.5	4.58
<u>III.</u>	40.	177.	4.	4.42
<u>IV.</u>	35.	153.	3.5	4.29
<u>V.</u>	30.	125.	3.	4.17
<u>VI.</u>	39.	168.	3.9	4.3
<u>VII.</u>	49.	206.5	4.9	4.25
<u>VIII.</u>	38.	140.	3.8	3.7
<u>IX.</u>	23.	87.5	2.3	3.8
<u>X.</u>	28.	111.5	2.8	3.9

Table XI.

Shingles Greenpod.20 hills per plot.

Plot.	Total pods.	Total wt. of Pods.	av. pods per hill.	av. wt. green pod.
<u>I</u>	37.	90.	1.85	2.36
<u>II</u>	69.	242.	3.40	3.5
<u>III</u>	56.	226.	2.8	4.04
<u>IV</u>	62.	242.	3.1	3.9
<u>V</u>	49.	147.	2.40	3.02
<u>VI</u>	57.	234.	2.85	4.1
<u>VII</u>	49.	169.	2.40	3.40
<u>VIII</u>	35.	91.	1.93	2.56
<u>IX</u>	31.	95.	1.55	3.07
<u>X</u>	34.	113.	1.7	3.23

These two ~~above~~ tables show only the data for the first two pickings of beans, and not for the whole crop; therefore the yields are different from those obtained in the first crop. Should there have been time to ^{have} harvested the whole crop, the results would very likely have been the same as those obtained in the first experiment. The seemingly high yield from the plots which produced only ordinary yield was due to the pods being picked only the two times, as a comparison with the first two pickings of the first crop.

from those plots which produced so high yields in the second crop, will show that their yields were, then, large.

The ^{two} following tables give the percentages of the pods from the different plots, containing the different numbers of developed branes.

Table XII

"Early Mohawk"		Beans per Pod.					
Plot.	Total pods.	1.	2.	3.	4.	5.	6.
I	26.	19.5	23.	23.	19.5	10.8	
II	35.	5.6	11.2	22.4	33.6	16.8	8.4
III	40.	12.5	12.5	14.9	45.	12.5	2.5
IV	35.	8.82	11.4	17.6	36.5	19.6	5.6
V	30.	16.6	10.	13.6	36.6	23.1	
VI	39.	5.12	15.3	17.9	33.4	17.9	10.2
VII	49.	24.5	10.	18.4	12.4	26.4	8.8
VIII	38.	15.8	18.4	21.02	18.4	13.1	13.1
IX	23.	21.7	21.7	13.02	30.4	8.7	4.3
X	28.	14.3	7.1	21.4	39.2	17.8	

Table XIII.

"Stringless Greenpod"		Beans per pod.					
Plot.	Total pods.	1.	2.	3.	4.	5.	6.
I.	37.	36.9	18.4	13.5	16.2	8.1	2.7
II.	69.	8.7	8.7	7.2	20.3	42.	13.
III.	56.	8.9	10.7	26.8	21.4	28.6	3.5
IV.	62.	16.1	14.5	19.3	30.3	17.7	1.6
V.	49.	26.5	18.4	8.1	28.6	18.4	
VI.	57.	24.6	12.3	22.8	28.1	10.3	1.75
VII.	49.	24.5	14.3	16.3	20.4	22.3	2.04
VIII.	35.	42.8	28.6	8.6	17.1	2.8	
IX.	31.	25.9	19.3	20.4	19.3	12.9	
X.	34.	17.6	17.6	23.5	32.4	8.8	

The same results are shown in the two above tables, XII and XIII, as are shown in the yields and weights of the pods, from the second crop; that is, the variations in the percentages of pods containing a certain number of beans. This too, could probably have been over come, had there been time ^{for} ^{a further} harvesting of the crop.

Only one cooking test was made with the beans of the second crop, and that only with the "Early Mohawk" variety.

The cooking of the "Early Newbowl" pods gave results which verified those obtained in the cooking of the brans of the first crop. Plot II produced decidedly the best brans both as to flavor and amount of woody tissue present; and, as before, plots I and X produced the brans of poorest quality.

Conclusions.

The results of the investigations ^{reported} in this thesis warrant the following conclusions:

1. The quality as well as the yield of string brans is affected by the use of certain fertilizers.

2. On the type of soil used in this investigation, bone meal in combination with manure will produce brans of better quality than any other combination tried.

3. It is worthy of notice that every combination containing bone meal produced brans of better quality than any of the combinations without it.

3. Nitrate of soda used in connection with manure may increase

the yield of string beans, but does not improve the quality. Furthermore, when used in connection with manure and bone, or manure, bone, and fatless iron sulphate, on the type of soil used in this experiment, it does not improve the yield or quality, over manure alone.

4. The use of manure, either alone or in combination with other fertilizers, improves the quality as well as ~~as well as~~ the yield of string beans, as compared with soil without manure or fertilizer.

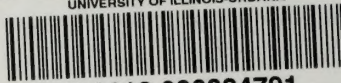
5. A deficiency of moisture in the soil results in impairing the quality as well as decreasing the yield of string beans.

6. Conditions favorable to ^{the development of} high quality in string beans, are also productive of large yields.





UNIVERSITY OF ILLINOIS-URBANA



3 0112 086824791